The NIEHS ^{137}Cs Irradiator

What is the 137Cs irradiator?

The irradiator is a sealed source gamma chamber that contains two ^{137}Cs radiation sources. The ^{137}Cs decays to ^{137m}Ba by way of beta emissions with the maximum beta energy of 512 keV. The resultant ^{137m}Ba subsequently decays to ^{137}Ba by gamma emission at an energy of 667 keV. The betas are absorbed by the source cladding material leaving only the gammas as the source of radiation within the cavity area. The irradiator was installed at NIEHS on May 1, 1981.

Exposure rate curves for a variety of cavity setups, both by turn table position and by the amount of attenuation shields, are found attached to this procedure. These exposure curves must be corrected to compensate for the radioactive decay, ^{137}Cs has a 30 year half life. The correction factors charted by year and month are listed on page 5 of this procedure.

Be aware that the rate curves in the technical manual are plotted in units of Roentgen/min which is a measure of exposure in air. This unit of measure must be multiplied by 0.96 in order to convert Roentgen/min to rad/min which is a measure of dose rate in tissue (0.96 Rad/Roentgen). Also, note that there are 100 rad per one Gray (1 Gray = 100 rad).

How are exposure rates determined?

Plots of exposure rates by position and by attenuator (shielding) are provided at the end of this procedure. These exposure rates must be corrected for radioactive decay, see chart on page 5 for correction factors by year and month. Note that attenuators are sequential meaning that the X-10 attenuator includes the X-2, X-5 and X-10 attenuator. Attenuators are positioned by sliding them into place in front of the source guide tubes at the rear of the irradiator cavity.

Who can use the irradiator?

Only personnel authorized by the NIEHS Radiation Safety Officer may have unescorted access to the irradiator. A list of personnel approved for unescorted access can be found in the Irradiator Log located in the Security Office. The list can also be found at the following web site: https://apps.niehs.nih.gov/hsb_all/ss_rpt.cfm.

Personnel approved for unescorted access must be trained to use the irradiator. The Radiation Safety Officer provides hands on training upon request. Refresher training is required every two years. Other personnel may accompany an authorized user but shall never be allowed to operate the irradiator or to be left unattended in the irradiator room or given procession of the irradiator room key. Escorts are to be vigilant for behavior which may suggest an interest in acquiring unauthorized access to the radioactive material through defeating the control program or other means. For example, the escort should

notice if the visitor shows an unusual amount of interest in the systems, equipment, and procedures used to control access to the irradiator. Notify the Radiation Safety Officer or NIEHS Security Officer if you detect unusual amount of interest by a visitor.

When can the irradiator be used?

The irradiator is available for use 24 hours a day, seven days a week. Occasionally the irradiator is taken out of service for repair or maintenance, authorize users will be notified of such outages. The access key to the irradiator is available in the Security Office which is open 24 hours a day.

Do you need to reserve a time to use the irradiator?

Reservations to use the irradiator are required so as to minimize conflicts with other researchers. Reservations are made on line via an interactive calendar at web link https://apps.niehs.nih.gov/hsb/rooms/ss_sched.cfm . Only those personnel authorized for unescorted access have access to the on line reservation system.

Please be considerate to other researchers by returning the irradiator key as soon as possible after your exposure is complete. Remember that there is only one access key to the irradiator. Do not retain this key since others may need it for their experiments.

Security of the irradiator and access keys.

The irradiator and irradiator room must be locked or the irradiator must be under direct surveillance of authorized users at all times. Do not leave the irradiator room door open or ajar. A security alarm will activate if the door is left open for more than a short period of time. The irradiator access key must be in the direct possession of an authorized user or in the key capture block in the Security Office. Never leave the key to the irradiator room unattended.

What if you have difficulty operating the irradiator?

Call the Radiation Safety Officer (1-0325) or Health Physicist (1-4235) if you encounter any difficulties operating the irradiator. If after hours, notify the Security staff which will call the Radiation Safety Officer. Never attempt to override any of the electrical or mechanical interlocks. Only specifically licensed vendors are authorized by the Nuclear Regulatory Commission to perform maintenance or repairs of the irradiator.

Operation Procedure

1. Sign out irradiator access key at the Security Office. Record the date/time of key check out, your name, phone number, expected time key will be returned and the name of any accompanying personnel. The security officer is required to verify your identity by way of your NIEHS ID badge.

2. With the irradiator access key and your research material, proceed to the irradiator room (E001).

3. Verify that the radiation monitor outside E001 reads near zero. The radiation monitor is set to alarm at 2.5 mR/hr. If the monitor is alarming, do not enter the irradiator room and immediately call the Radiation Safety Officer to report the problem. Otherwise use the door key to access E001.

4. A Geiger counter is stored in the room on the selves. Turn on the Geiger counter and verify that it is properly operating, use the attached check source. Place the Geiger counter on the bucket at the irradiator cavity door. Remove the bicycle style lock from the irradiator cavity door and energized the irradiator control box using the small key in the power switch. Verify the power indicator light (yellow lamp to the left of power switch) illuminates upon energizing the irradiator control box.

5. Check the source position indicators to ensure that both sources are in the shielded position. Open the irradiator cavity door by pressing the red release button on the door release to the left of the irradiator cavity and pulling on the door latch handle. The door will not open if the irradiator control box does not have power, if the sources are not in the shielded position or the door is not fully closed. If the Geiger counter response is excessive close the cavity door and notify the Radiation Safety Officer. Otherwise open the irradiator door and continue.

6. Place the appropriate shields and turn table in place along with your samples in the irradiator cavity. Cautiously close the irradiator cavity door; be sure your

fingers are clear of the door edge. If desired, select the appropriate turntable speed using the toggle switch to the left side of the machine.

7. Select either one or two sources using the selector toggle switch. Select preset or manual operation. If preset is selected, set the desired exposure time (time is in whole, tenths and hundreds of minutes) and push the reset button. Verify that the time selected is displayed on the digital readout.

8. Push the red irradiate button. The source or sources should rise and the clock will begin to count down. If the sources do not rise, check to ensure the door is properly latched and the there is at least 60 psi of air pressure as measured on the house air supply line located on the wall to the right of the irradiator. If the house air is low, the gas cylinder may be used as a source of air to operate the sources. Notify the Radiation Safety Officer if you encounter any difficulty operating the irradiator.

   Note: When the source is exposed, interlocks prevent opening the cavity door. In the event of a power failure, the sources automatically return to the "Shielded" position. Power must be available to the control box to operate the cavity door.

9. The source may return to the "Shielded" position by either of two modes:
   a. Automatically, by expiration of time preset on digital timer; or
   b. Manually, by pushing the "OFF" button.

10. Once your the exposure is complete, ensure the sources are in the shielded position before opening the cavity door. If the Geiger counter response becomes excessively high, close the cavity door and notify the Radiation Safety Officer. Otherwise open the irradiator door and continue.

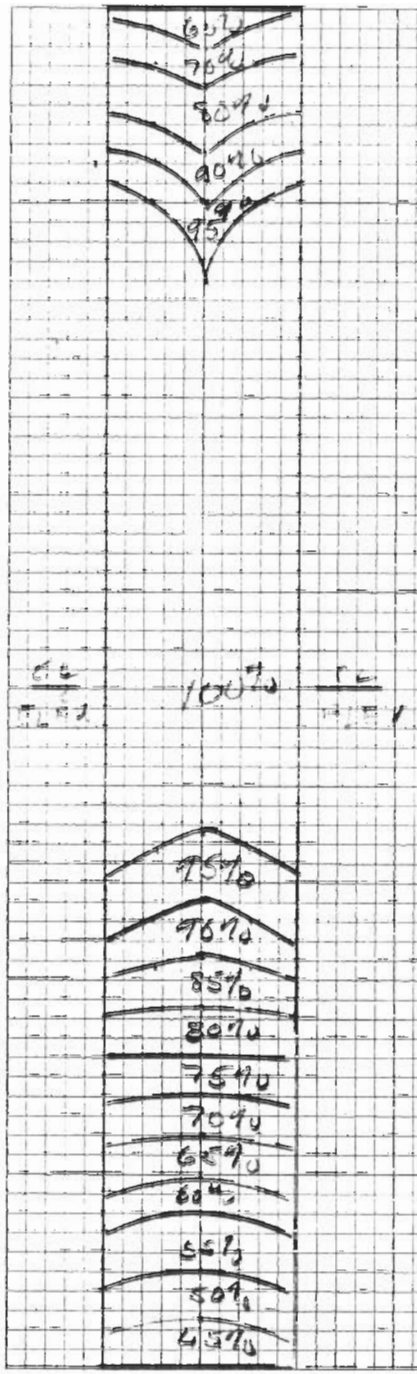
11. Remove your samples, the turn table, and all shields.

12. Shut and lock the cavity door. Turn off the irradiator control box and remove the operation key. Turn the Geiger counter off. Exit the irradiator room and return the irradiator key to the Security Office.

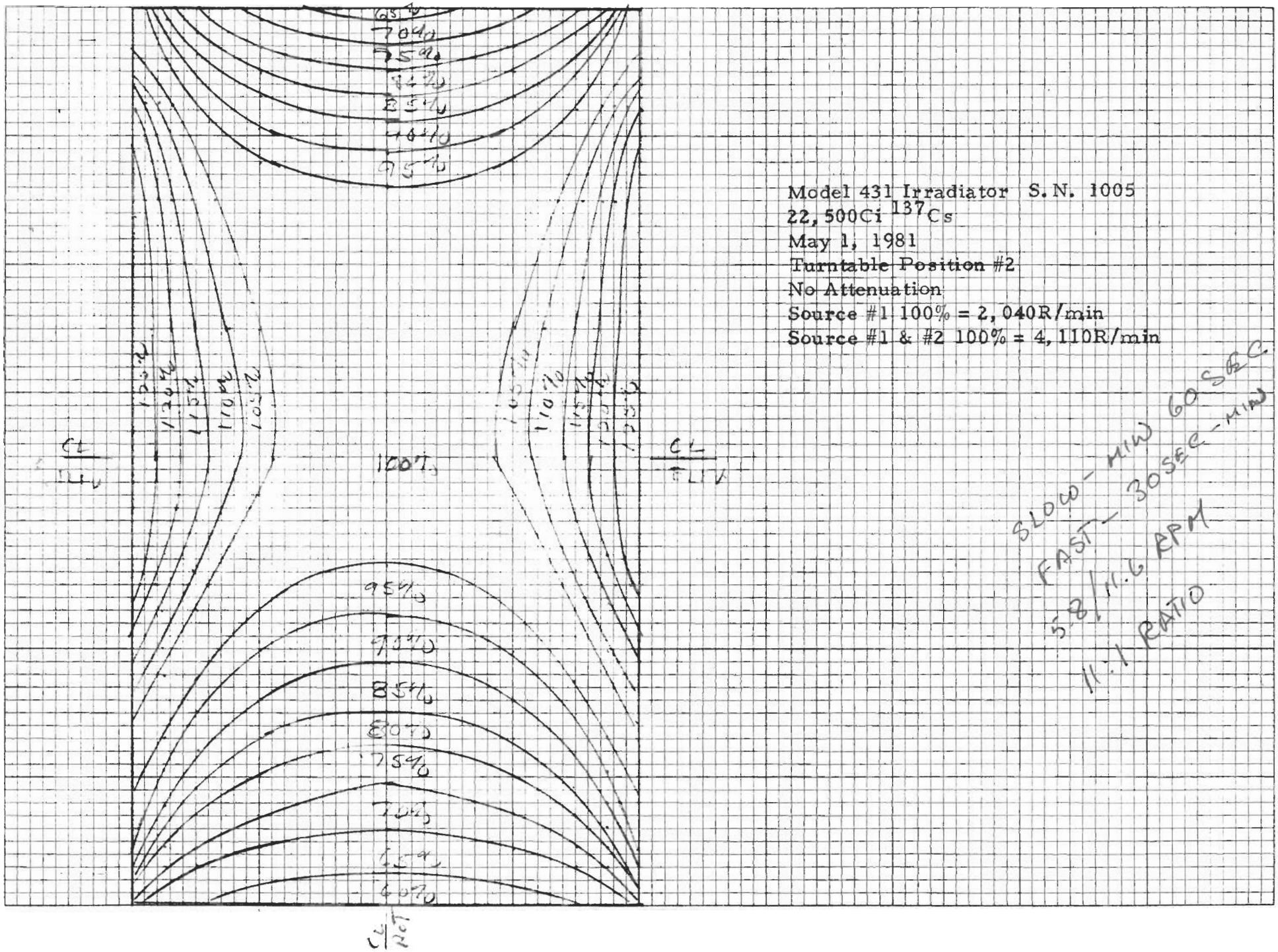
13. Record the time that the key is returned to the Security Office in the log book. Hand the key to the Security Officer.

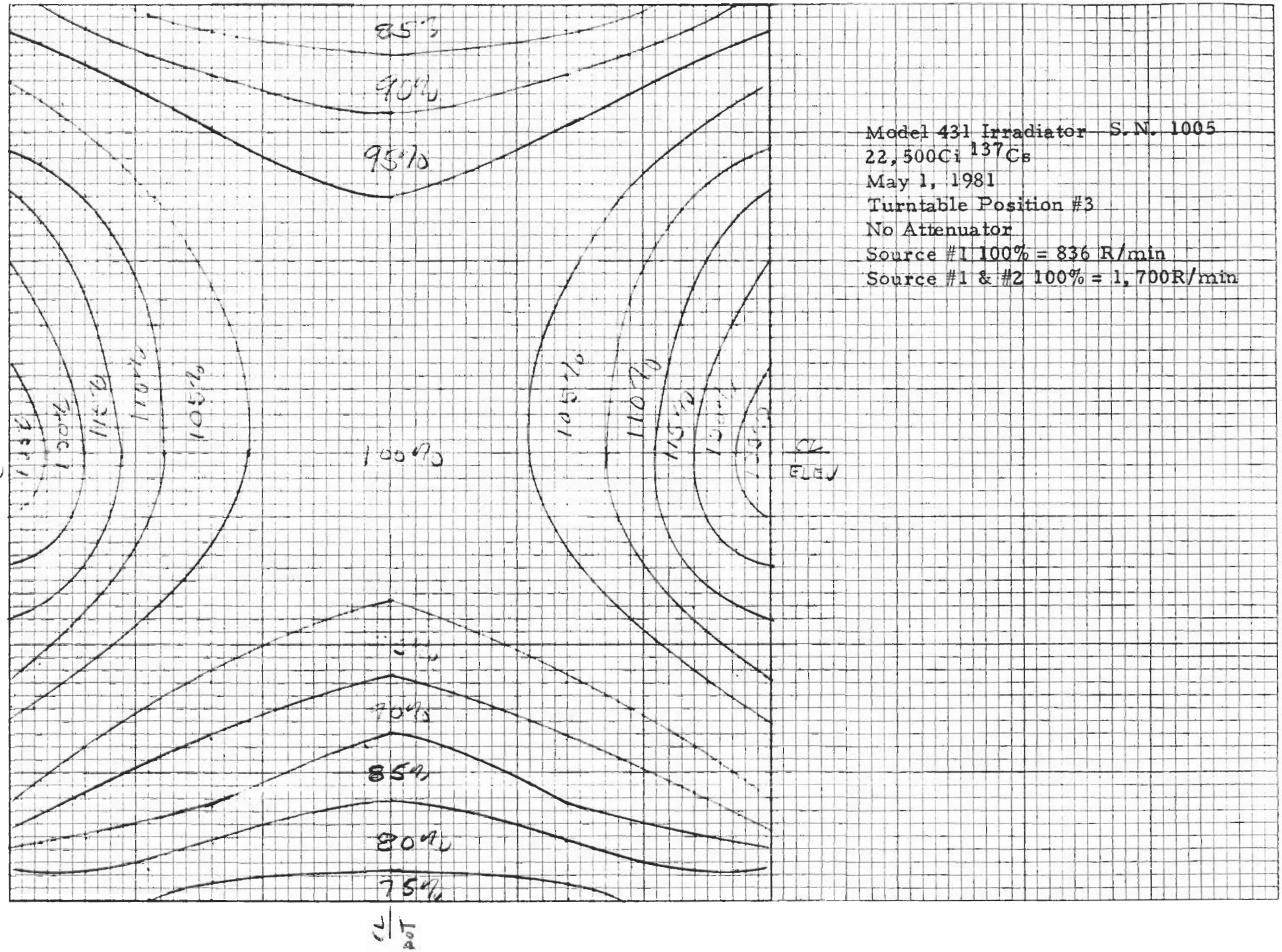
Effective Exposure Rate Fraction

Year	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2005	0.578	0.577	0.576	0.575	0.574	0.573	0.572	0.571	0.570	0.569	0.567	0.566
2006	0.565	0.564	0.563	0.562	0.561	0.560	0.559	0.558	0.557	0.556	0.554	0.553
2007	0.552	0.551	0.550	0.549	0.548	0.547	0.546	0.545	0.544	0.543	0.542	0.541
2008	0.540	0.539	0.538	0.537	0.536	0.535	0.534	0.532	0.531	0.530	0.529	0.528
2009	0.527	0.526	0.525	0.524	0.523	0.522	0.521	0.520	0.519	0.518	0.517	0.516
2010	0.515	0.514	0.513	0.512	0.511	0.510	0.509	0.508	0.507	0.506	0.505	0.505
2011	0.504	0.503	0.502	0.501	0.500	0.499	0.498	0.497	0.496	0.495	0.494	0.493
2012	0.492	0.491	0.490	0.489	0.488	0.487	0.486	0.485	0.485	0.484	0.483	0.482
2013	0.481	0.480	0.479	0.478	0.477	0.476	0.475	0.474	0.473	0.473	0.472	0.471
2014	0.470	0.469	0.468	0.467	0.466	0.465	0.464	0.463	0.463	0.462	0.461	0.460
2015	0.459	0.458	0.457	0.456	0.456	0.455	0.454	0.453	0.452	0.451	0.450	0.449
2016	0.449	0.448	0.447	0.446	0.445	0.444	0.443	0.443	0.442	0.441	0.440	0.439
2017	0.438	0.437	0.437	0.436	0.435	0.434	0.433	0.432	0.432	0.431	0.430	0.429
2019	0.418	0.418	0.417	0.416	0.415	0.414	0.414	0.413	0.412	0.411	0.411	0.410
2020	0.409	0.408	0.407	0.407	0.406	0.405	0.404	0.403	0.403	0.402	0.401	0.400

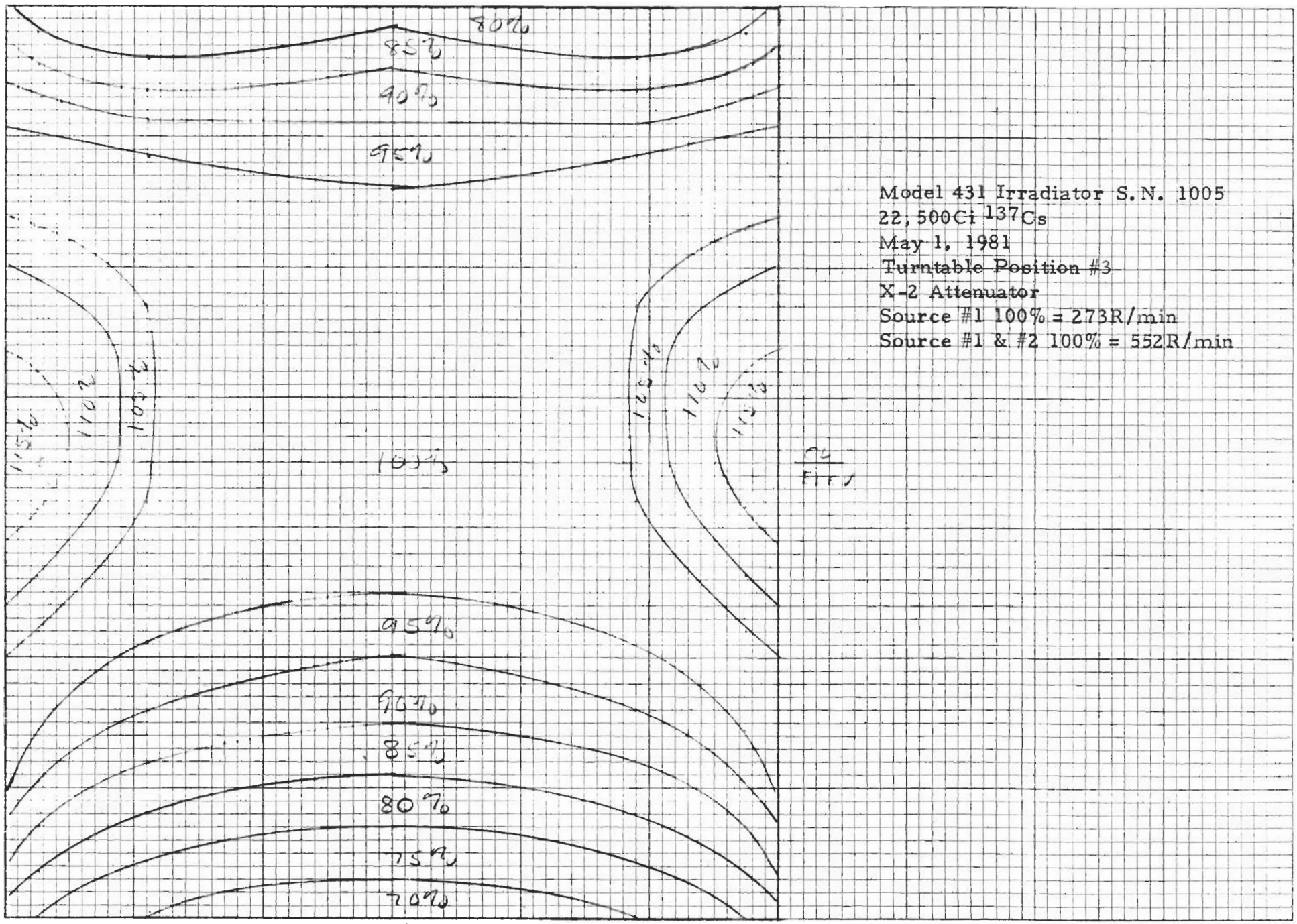


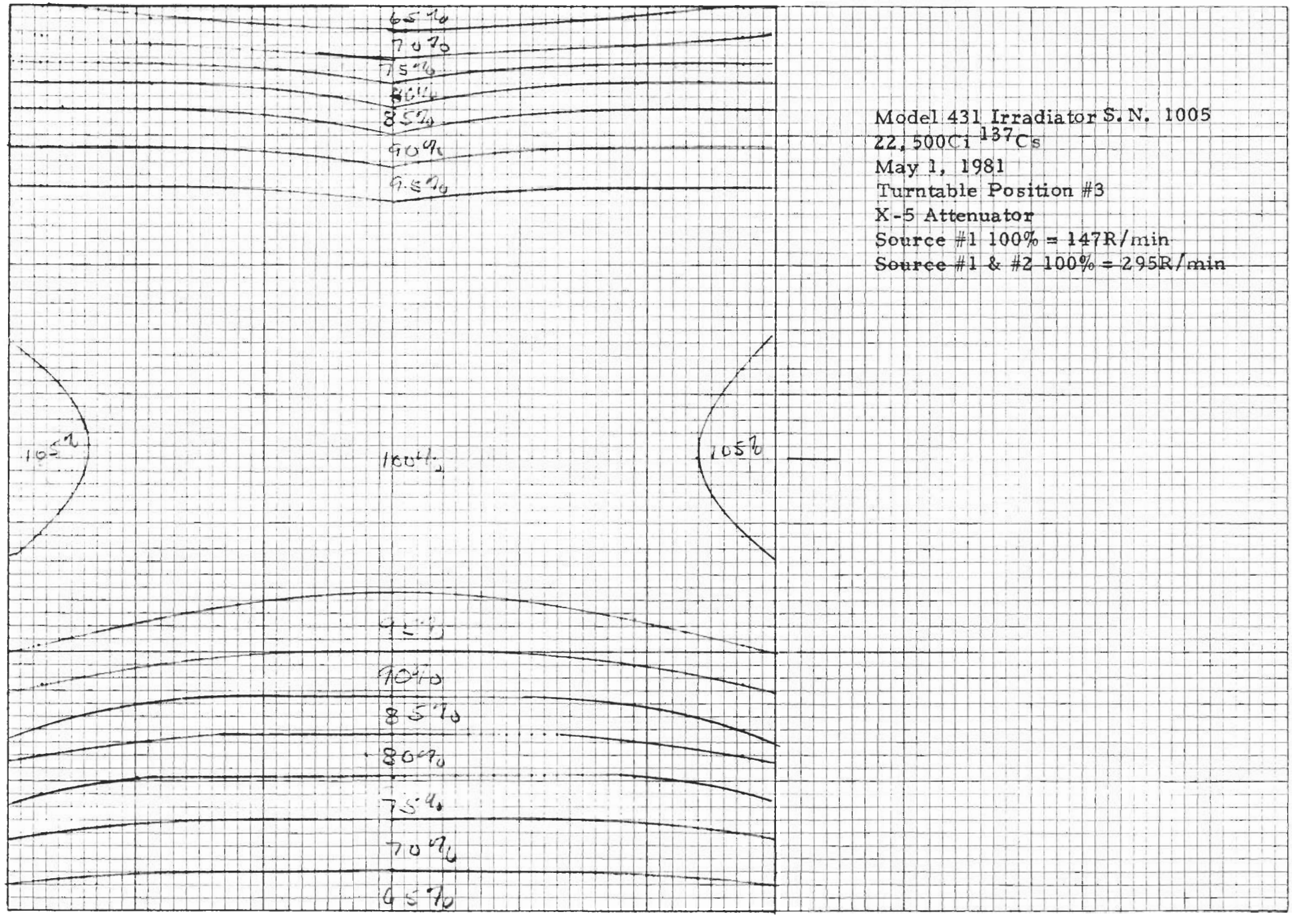
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #1
No Attenuation
Source #1 100% = 5,940R/min
Source #1 & #2 100% = 11,850R/min



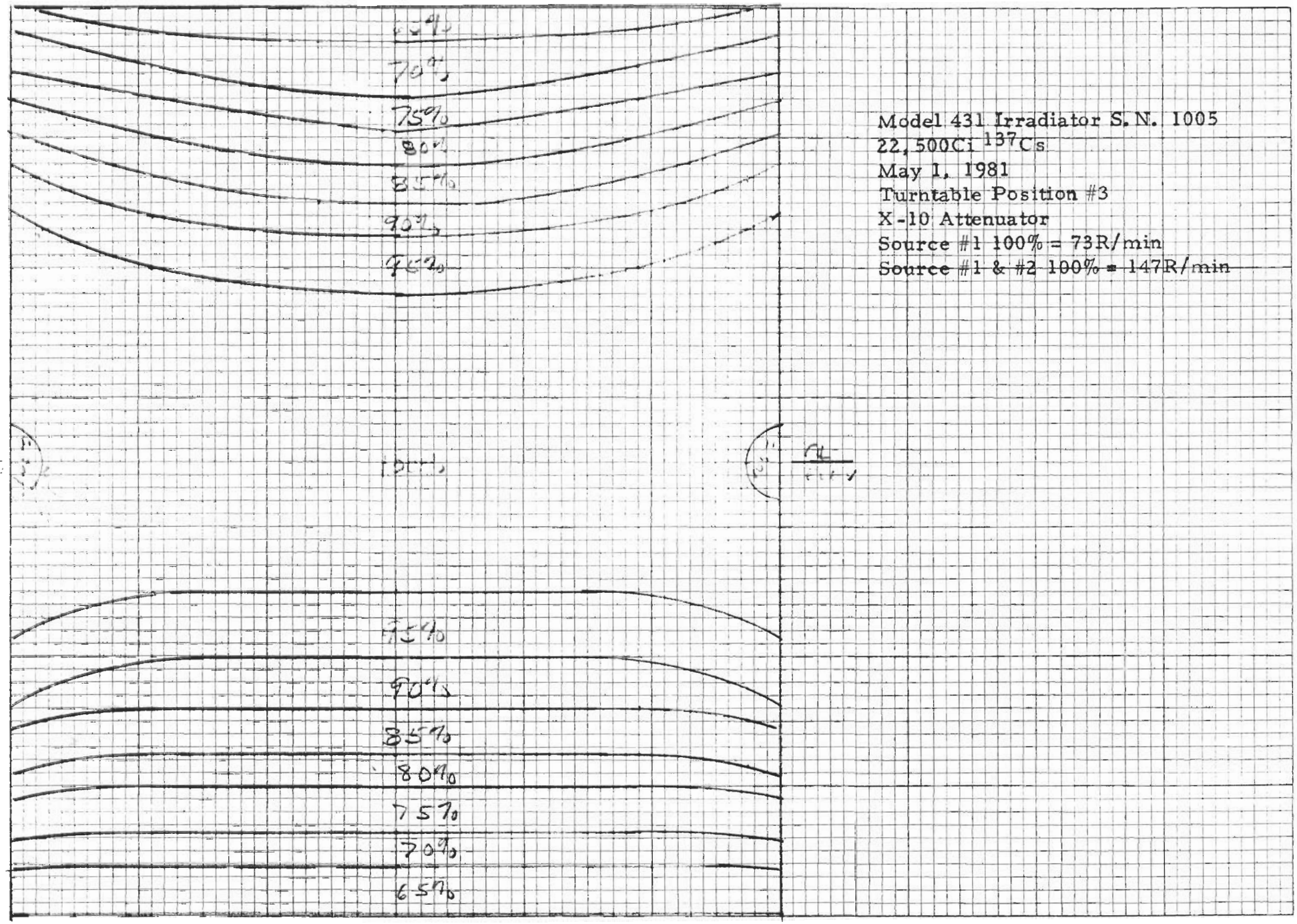


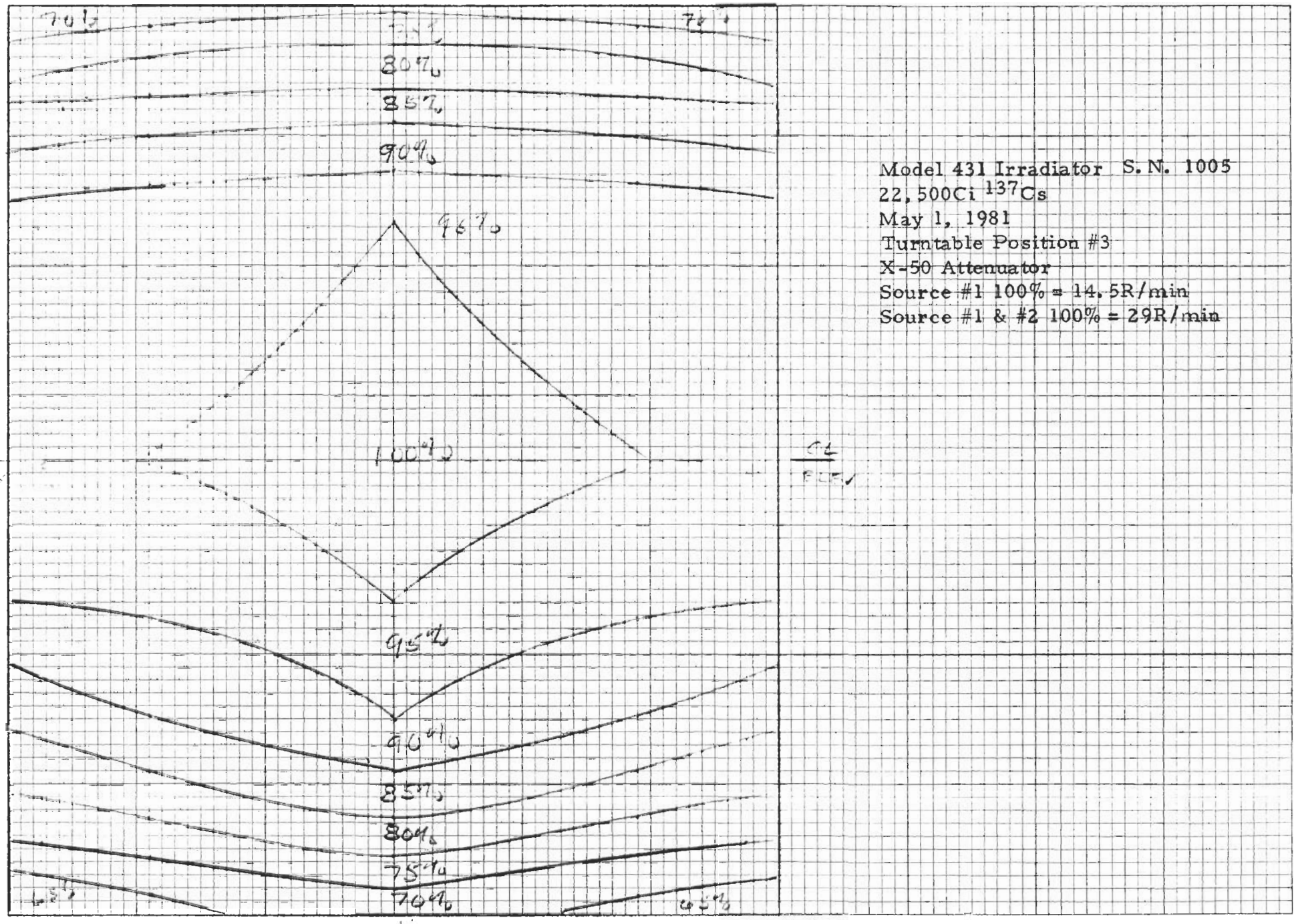
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #3
No Attenuator
Source #1 100% = 836 R/min
Source #1 & #2 100% = 1,700R/min



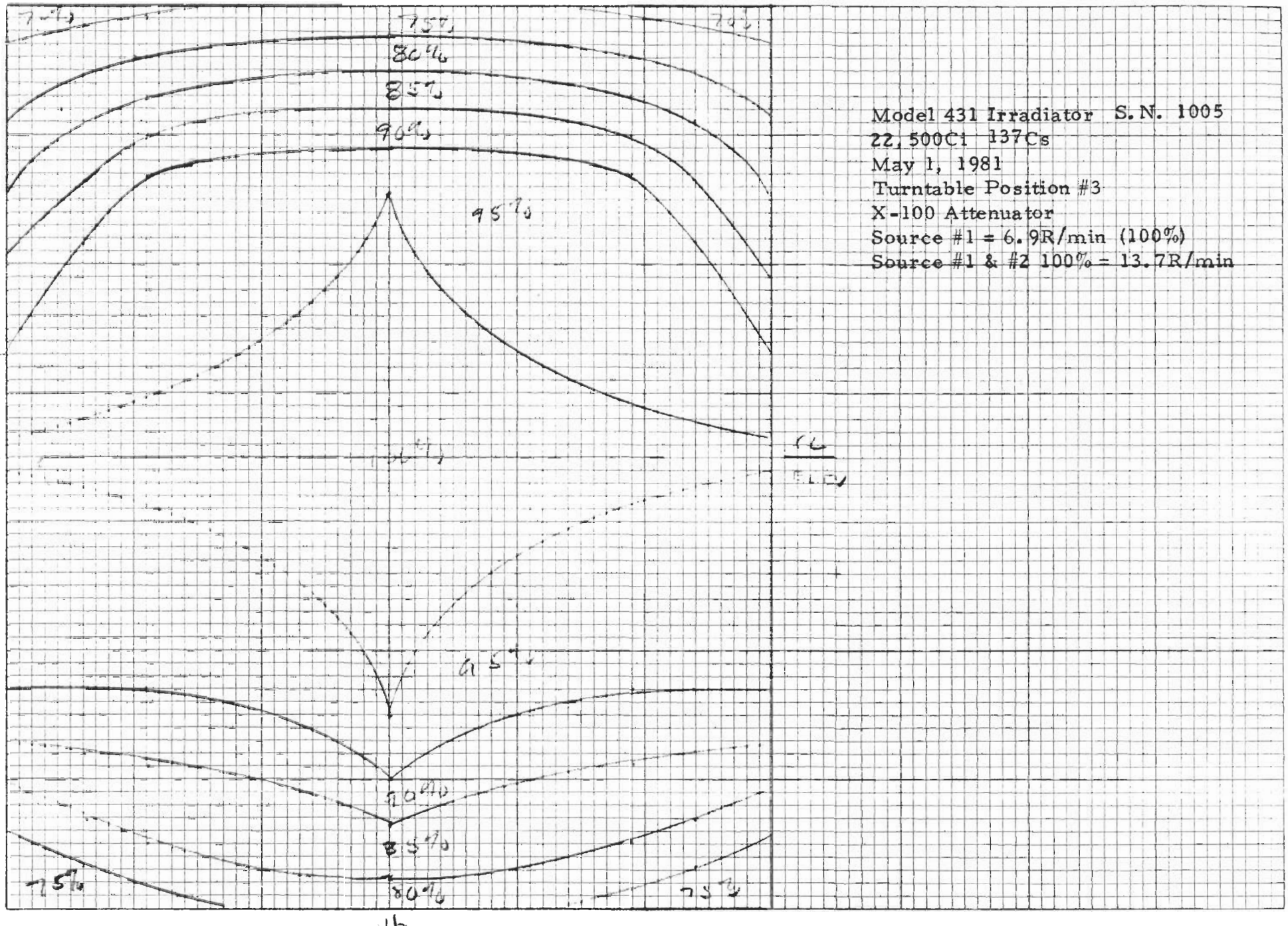


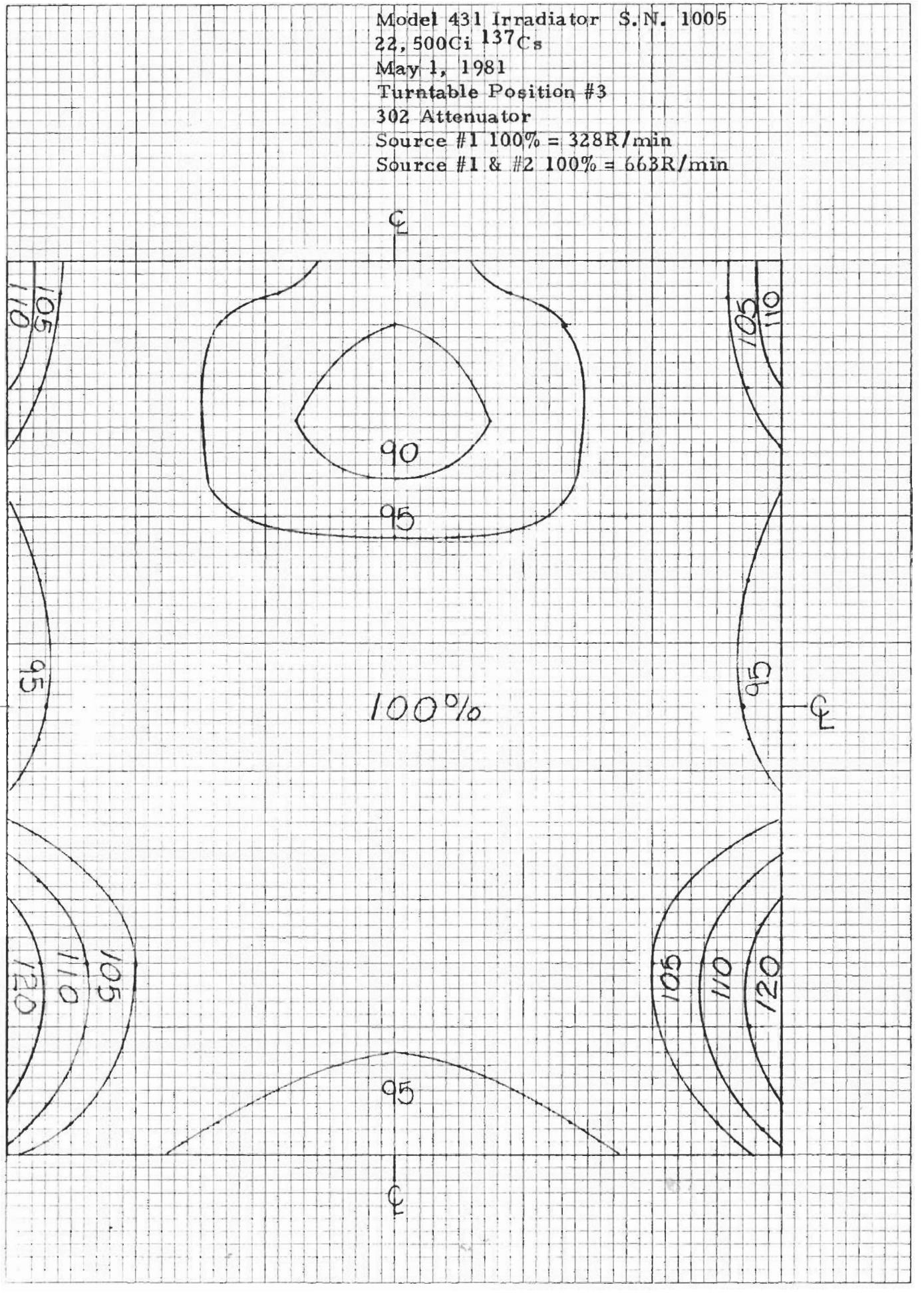
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #3
X-5 Attenuator
Source #1 100% = 147R/min
Source #1 & #2 100% = 295R/min

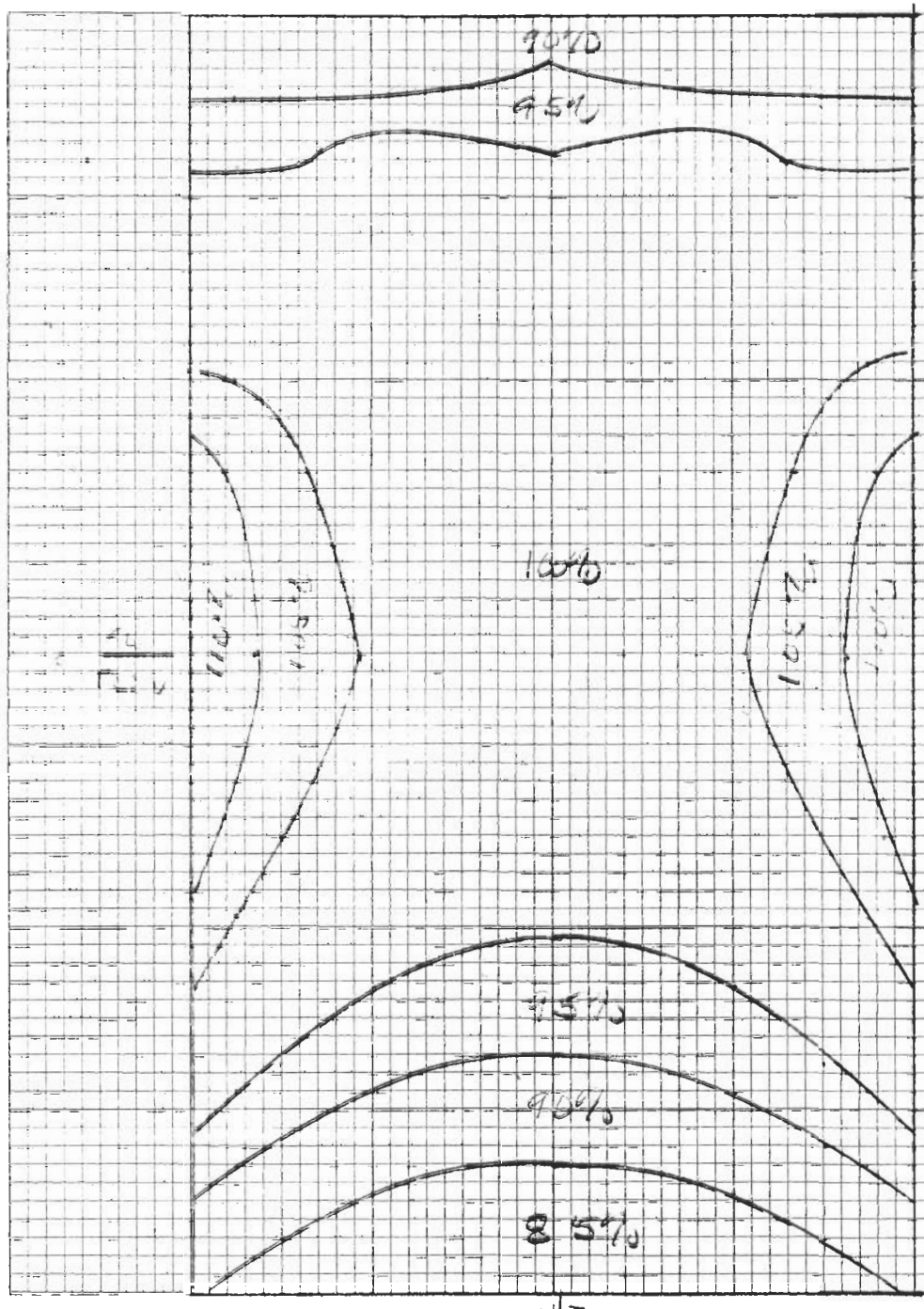




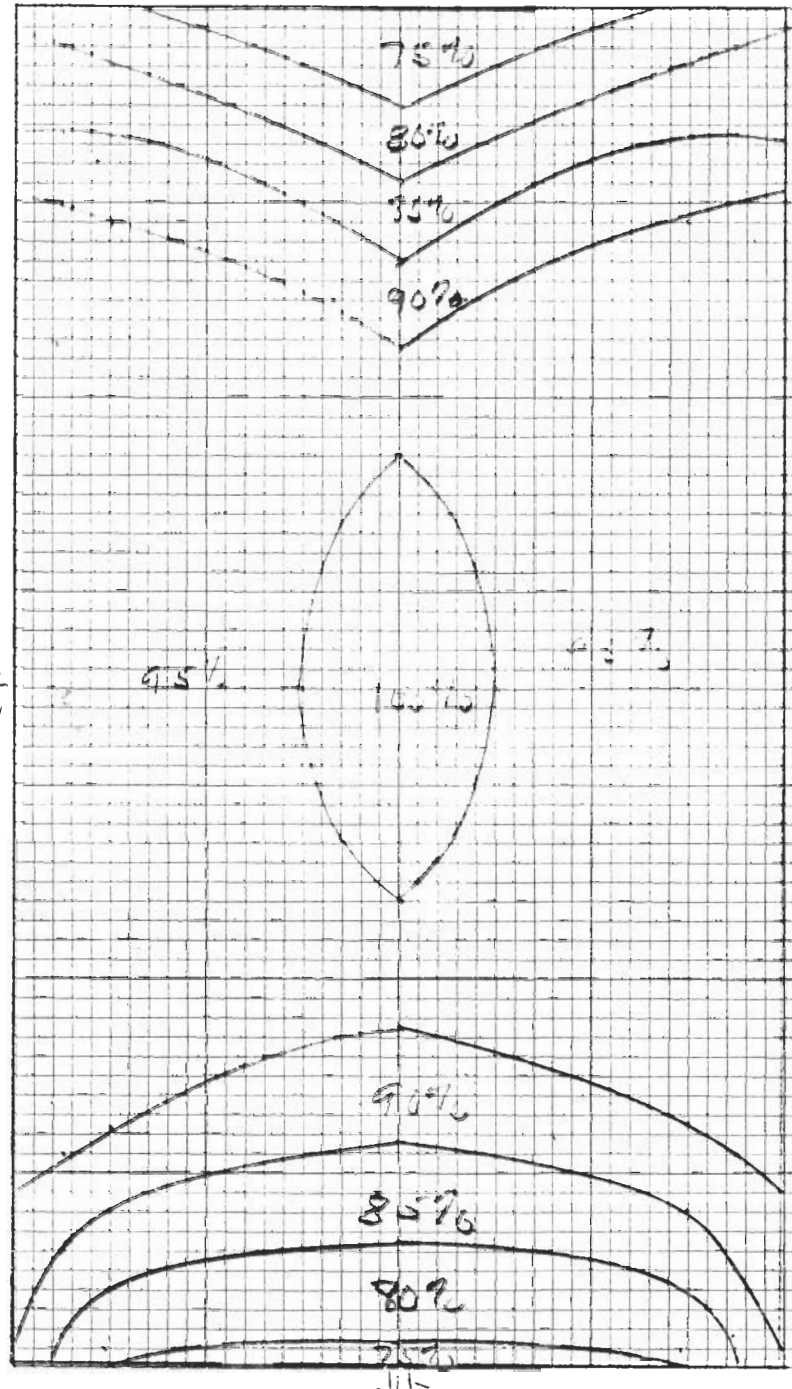
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #3
X-50 Attenuator
Source #1 100% = 14.5R/min
Source #1 & #2 100% = 29R/min



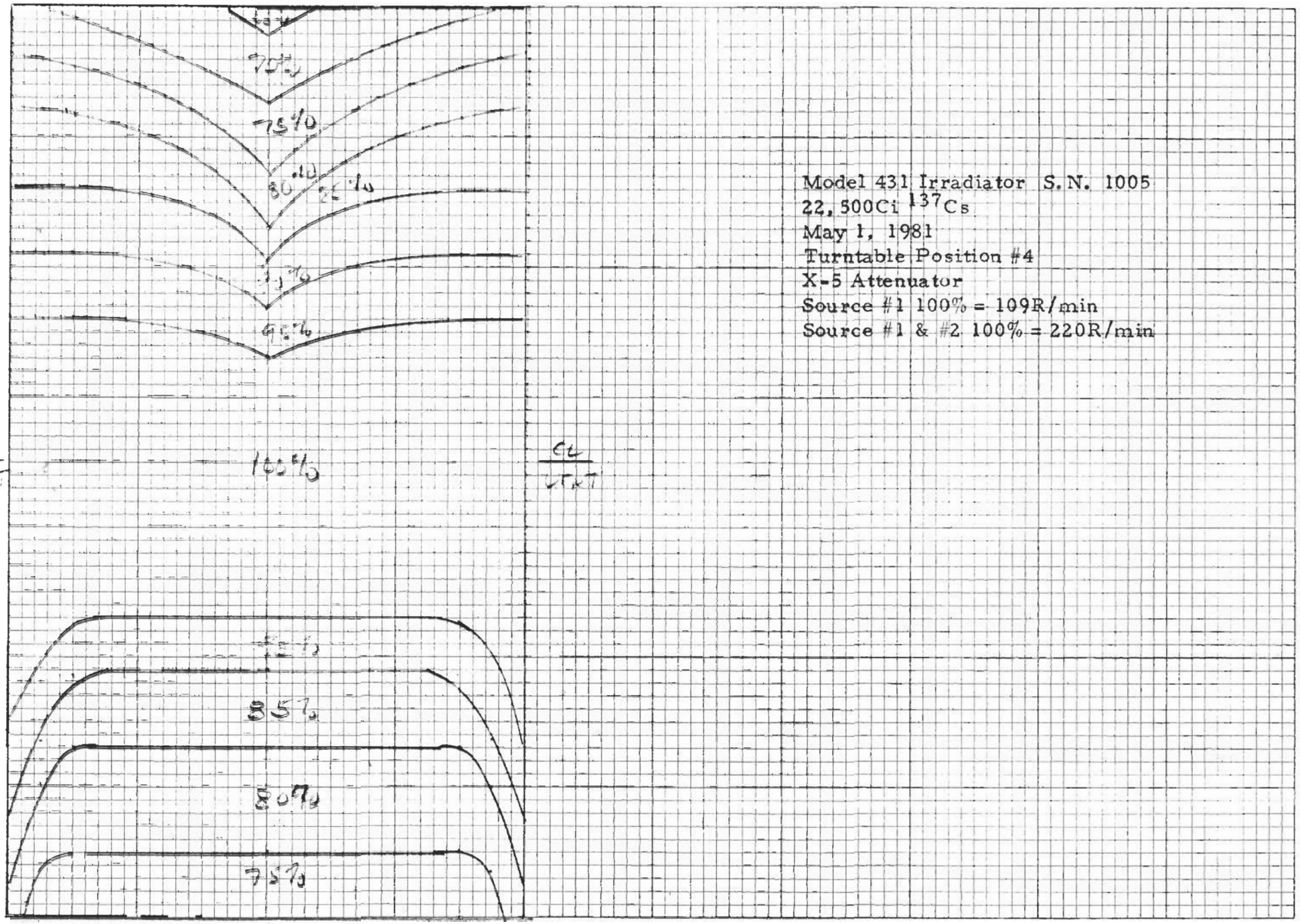


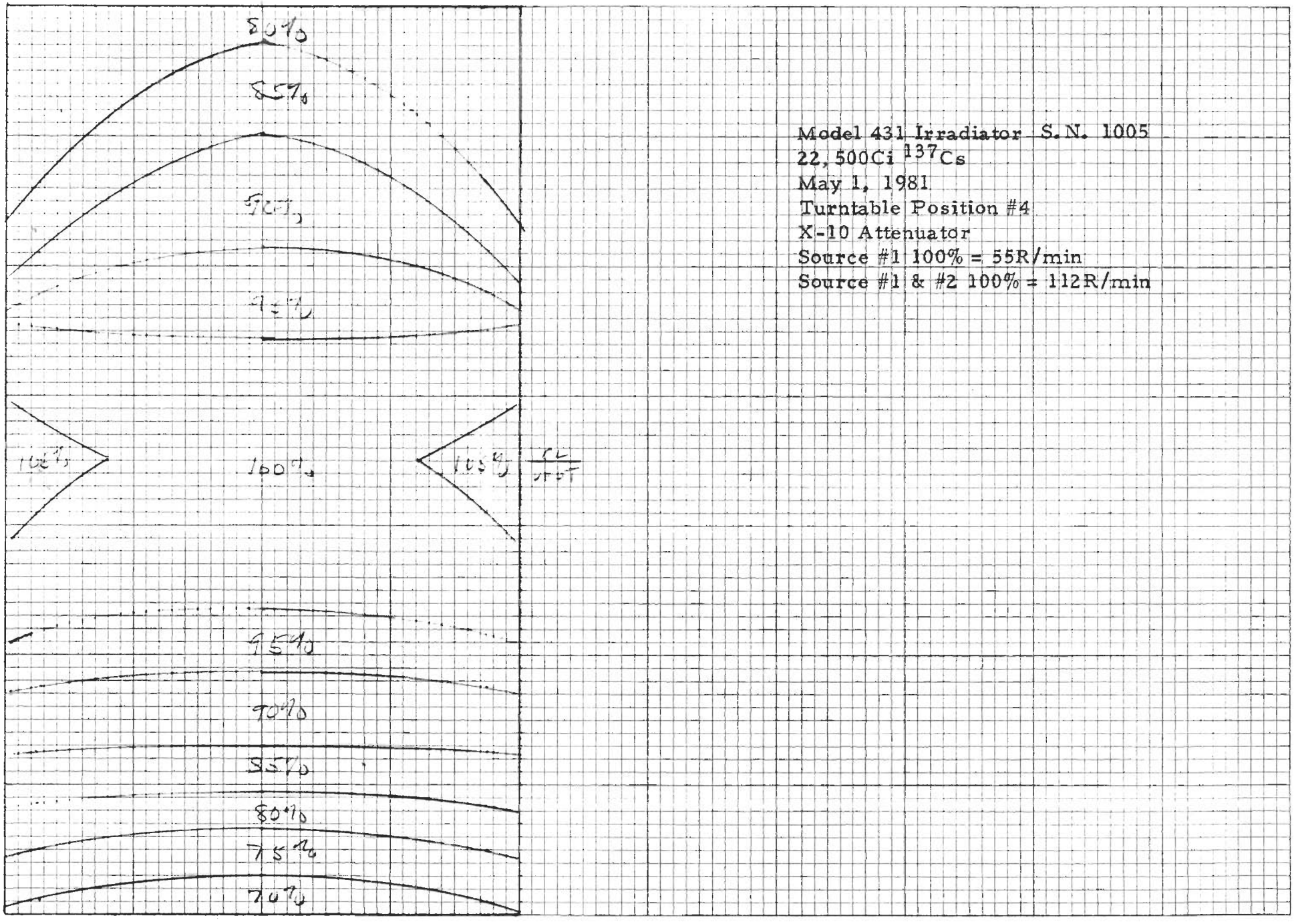


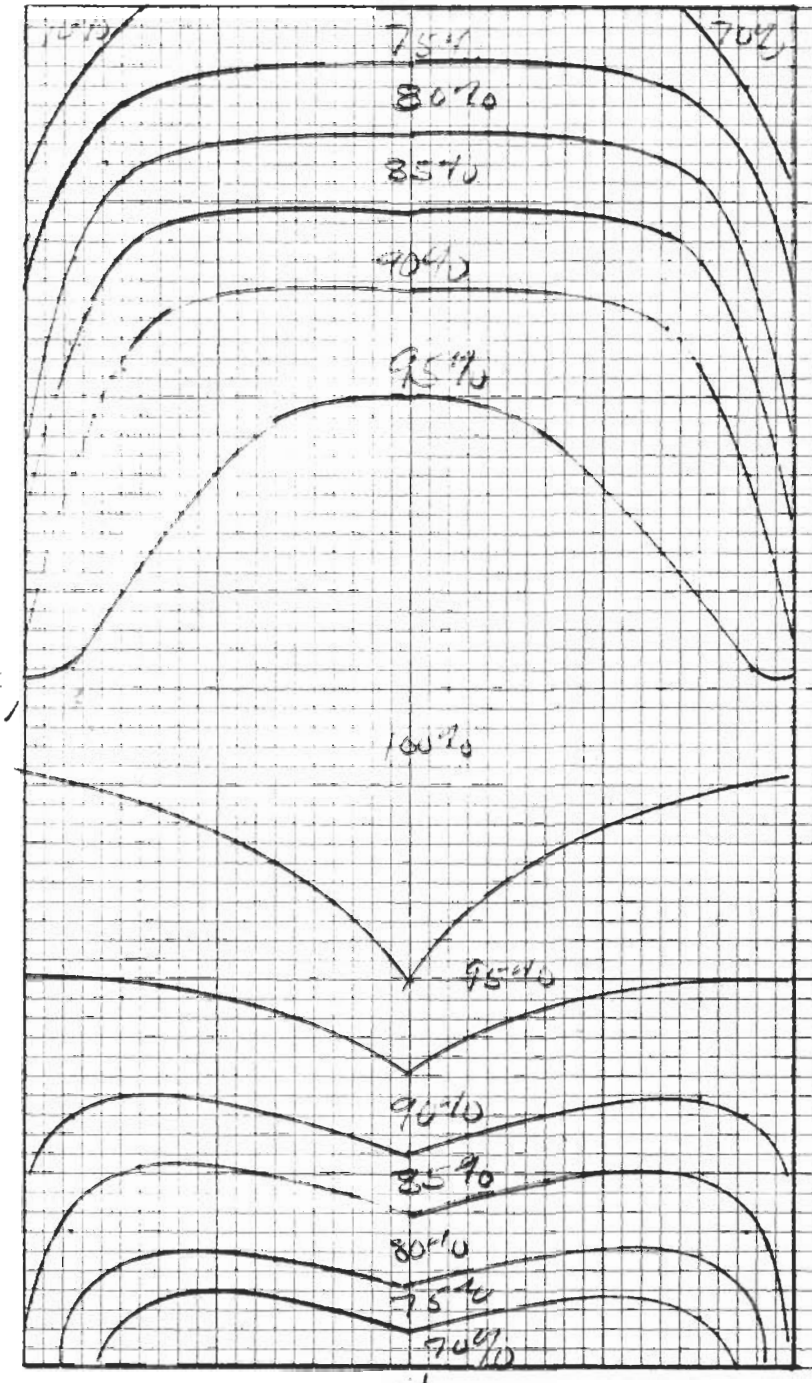
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #4
No Attenuator
Source #1 100% = 600R/min
Source #1 & #2 100% = 1,215R/min



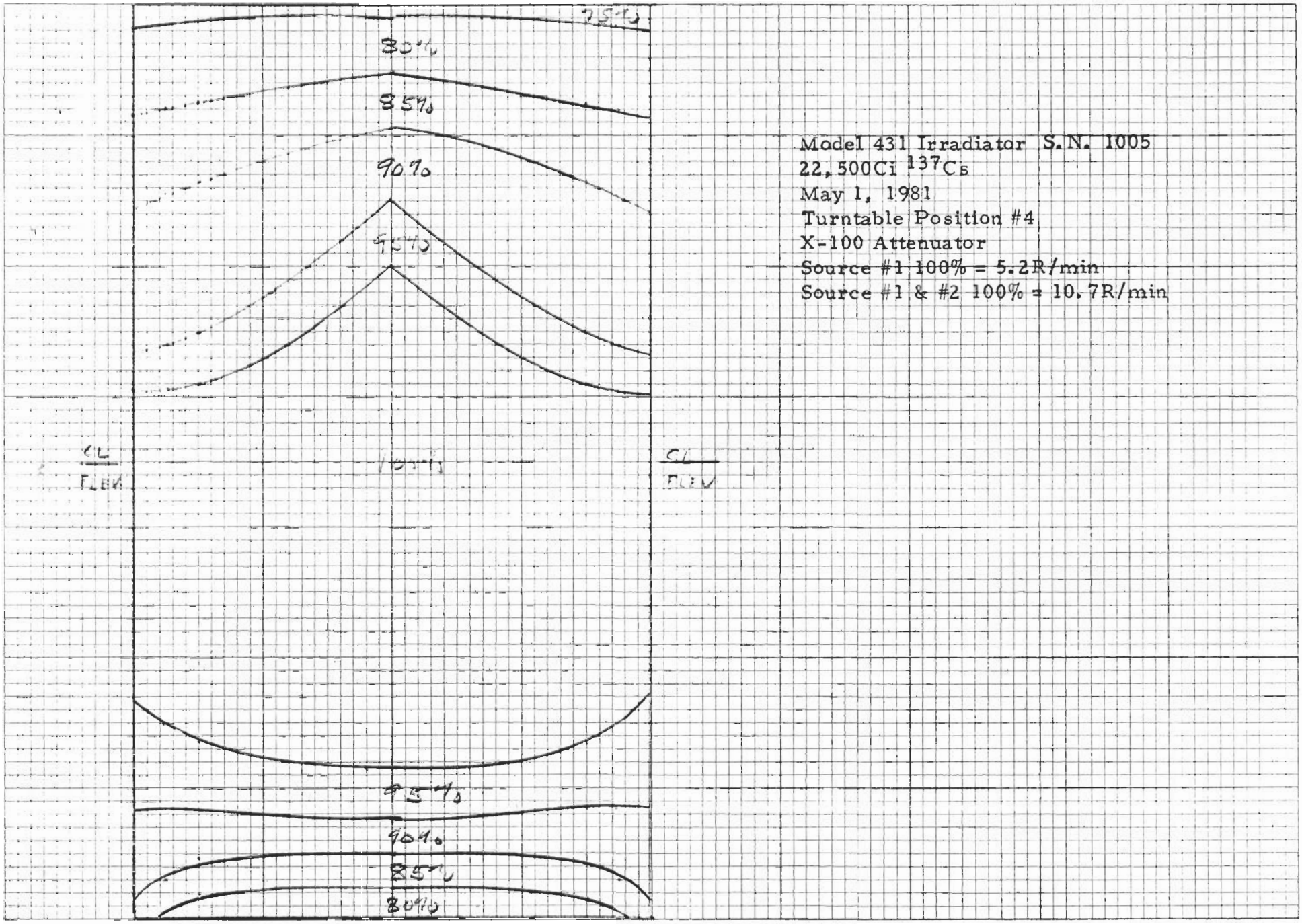
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #4
X-2 Attenuator
Source #1 100% = 301R/min
Source #1 & #2 100% = 610R/min





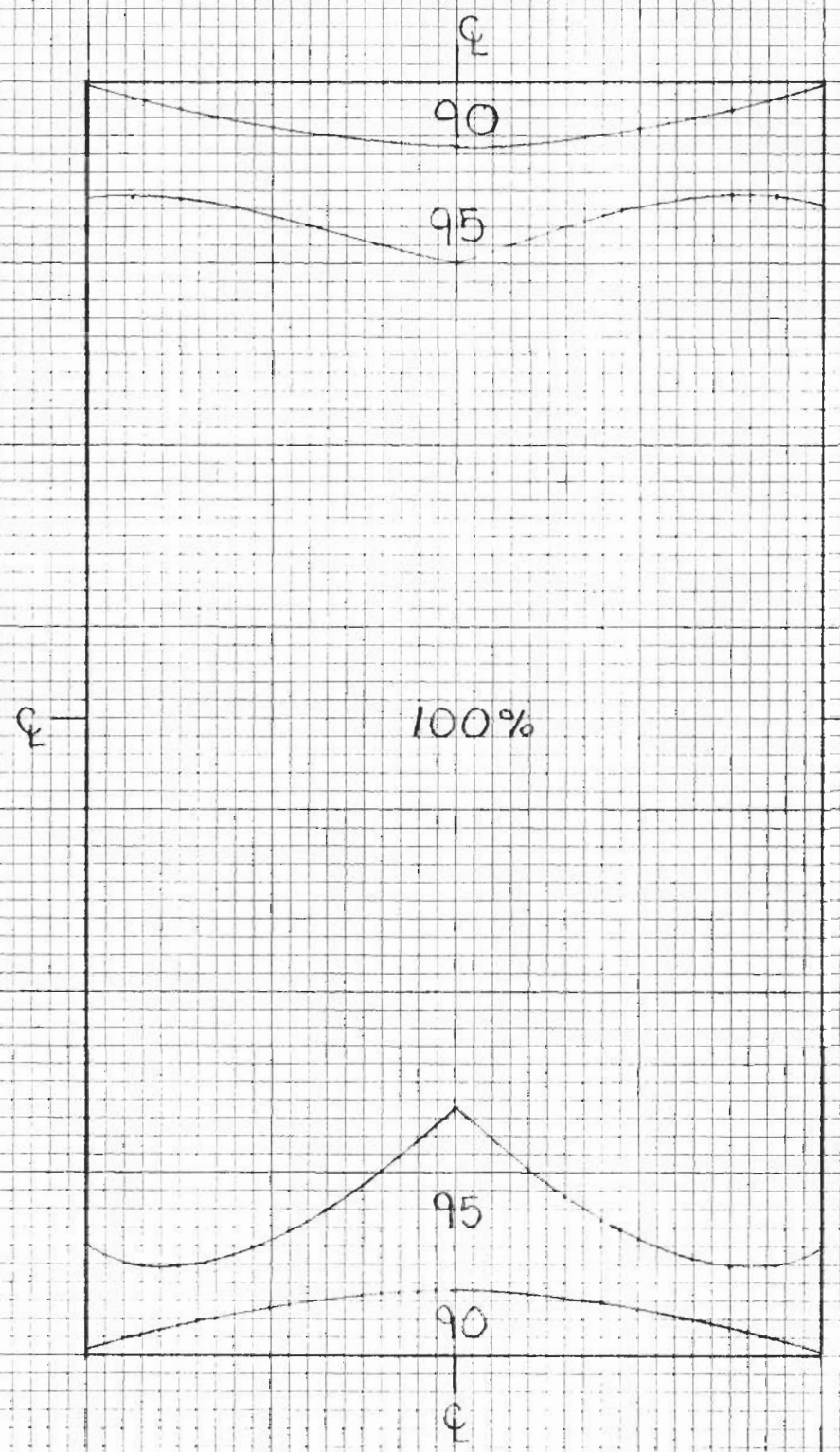


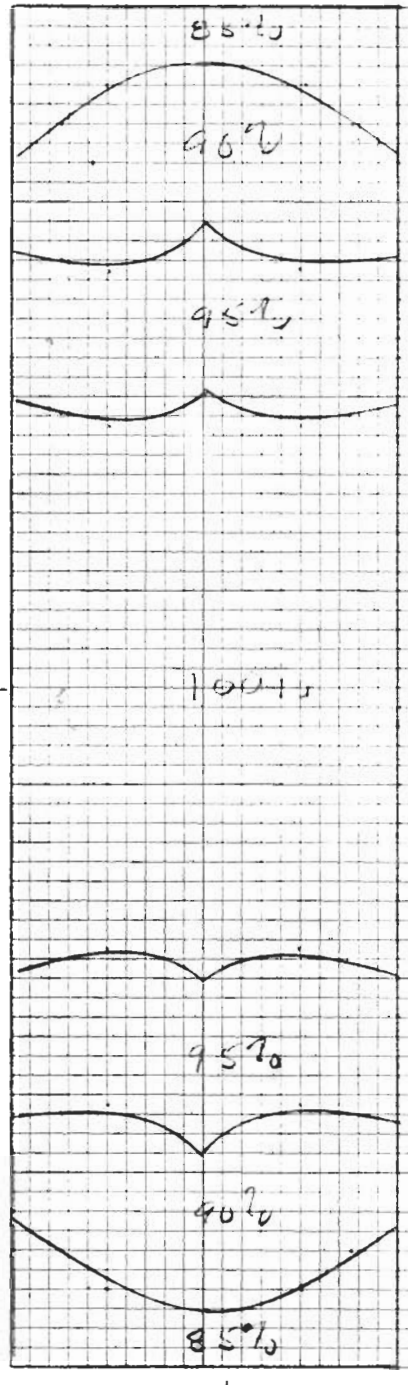
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #4
X-50 Attenuator
Source #1 100% = 11.1R/min
Source #1 & #2 100% = 22.6R/min



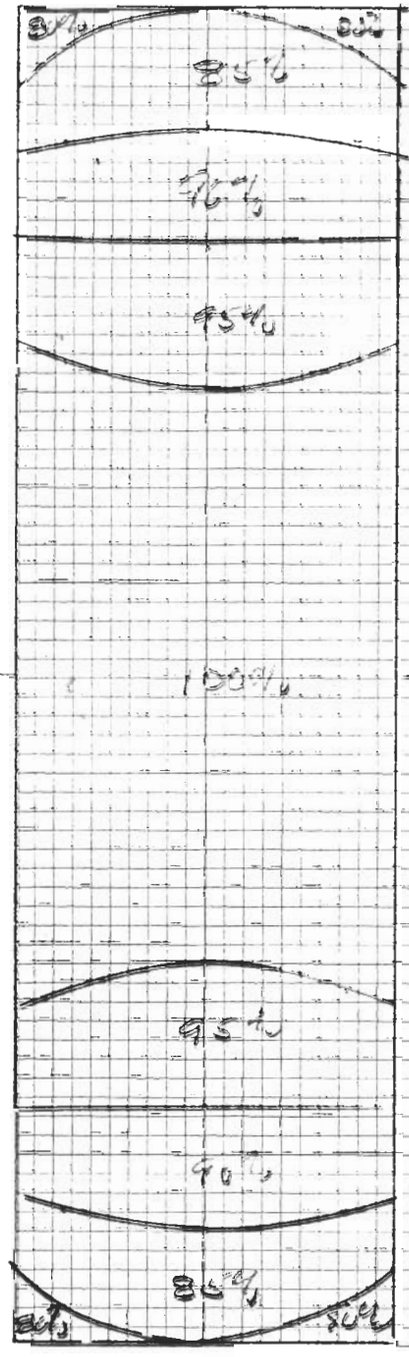
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #4
X-100 Attenuator
~~Source #1 100% = 5.2R/min~~
Source #1 & #2 100% = 10.7R/min

Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #4
302 Attenuator
Source #1 100% = 251R/min
Source #1 & #2 100% = 510R/min

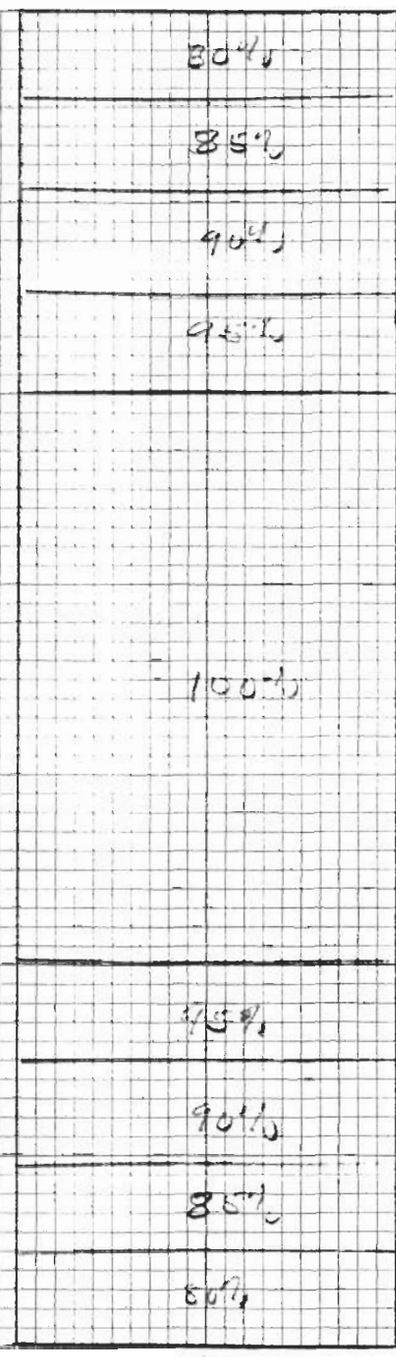




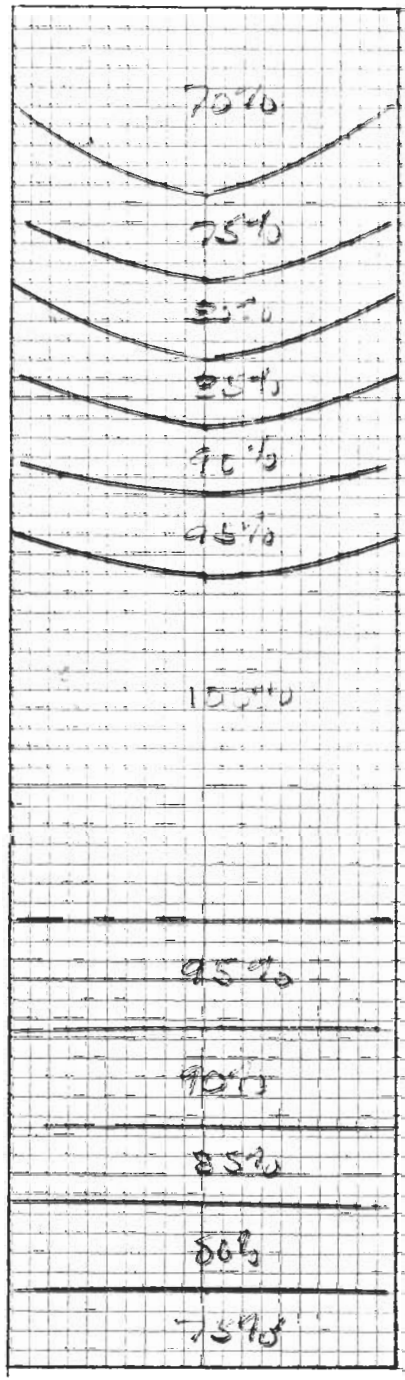
Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #5
No Attenuation
Source #1 100% = 465R/min
Source #1 & #2 100% = 950R/min



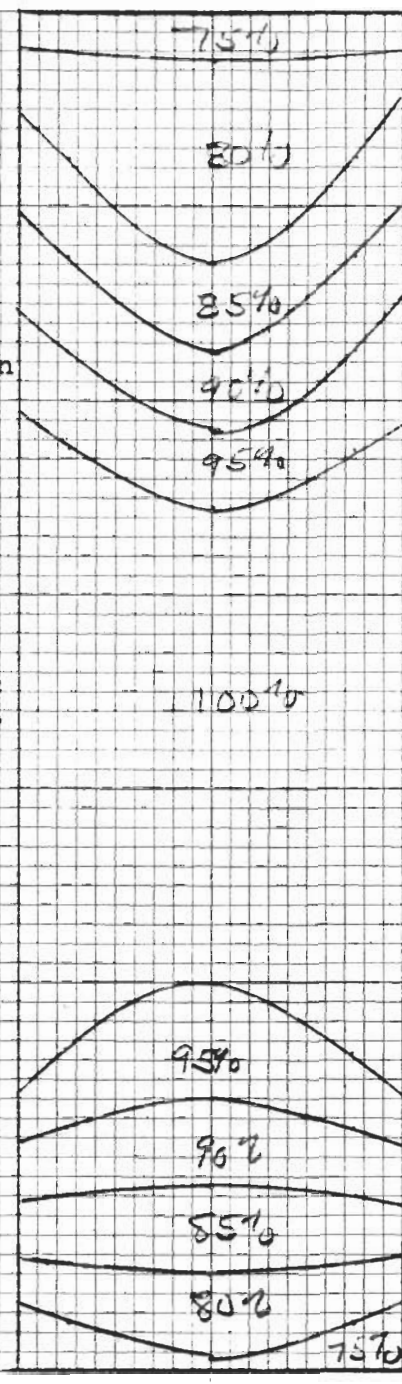
Model 431 Irradiator SN 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #5
X-2 Attenuator
Source #1 100% = 229R/min
Source #1 & #2 100%=468R/min



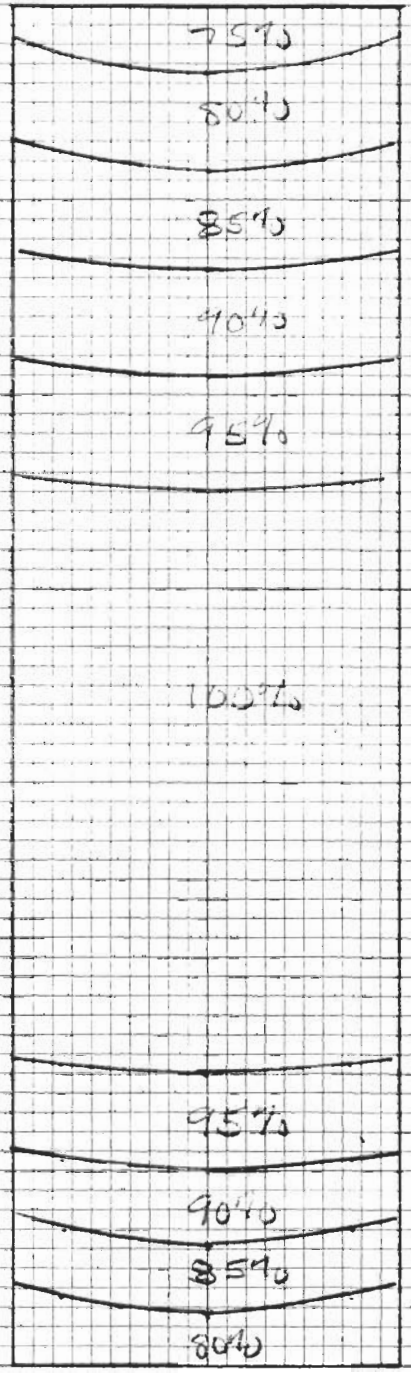
Model 431 Irradiator SN 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #5
X-5 Attenuator
Source #1 100% = 83.2R/min
Source #1 & #2 100%=170R/min



Model 431 Irradiator SN 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #5
X-10 Attenuator
Source #1 100%=42.8R/min
Source #1 & #2 100%=87.5R/min

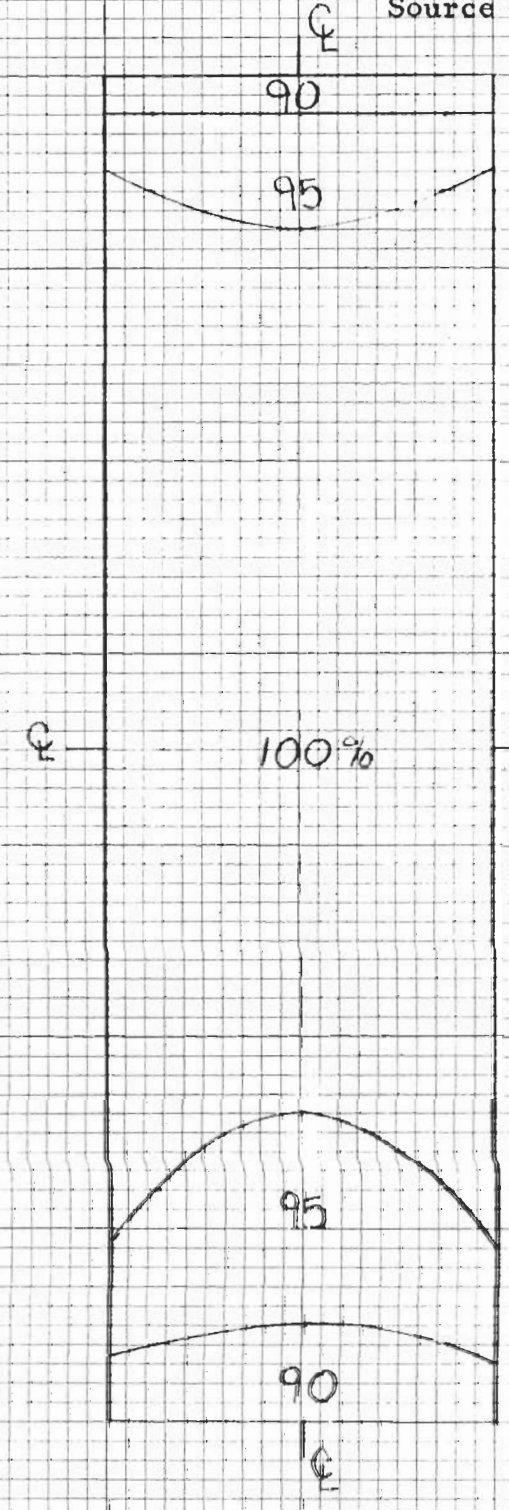


Model 431 Irradiator SN 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #5
X-50 Attenuator
Source #1 100%=8.76R/min
Source #1 & #2 100%=17.9R/min



Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1,1981
Turntable Position #5
X-100 Attenuator
Source #1 100% = 4.35R/min
Source #1 & #2 100% = 8.9R/min

Model 431 Irradiator S.N. 1005
22,500Ci ^{137}Cs
May 1, 1981
Turntable Position #5
302 Attenuator
Source #1 100% = 202R/min
Source #1 & #2 100% = 408R/min



Mark I Model 68A, S.N. 1005
11,250 Ci ^{137}Cs

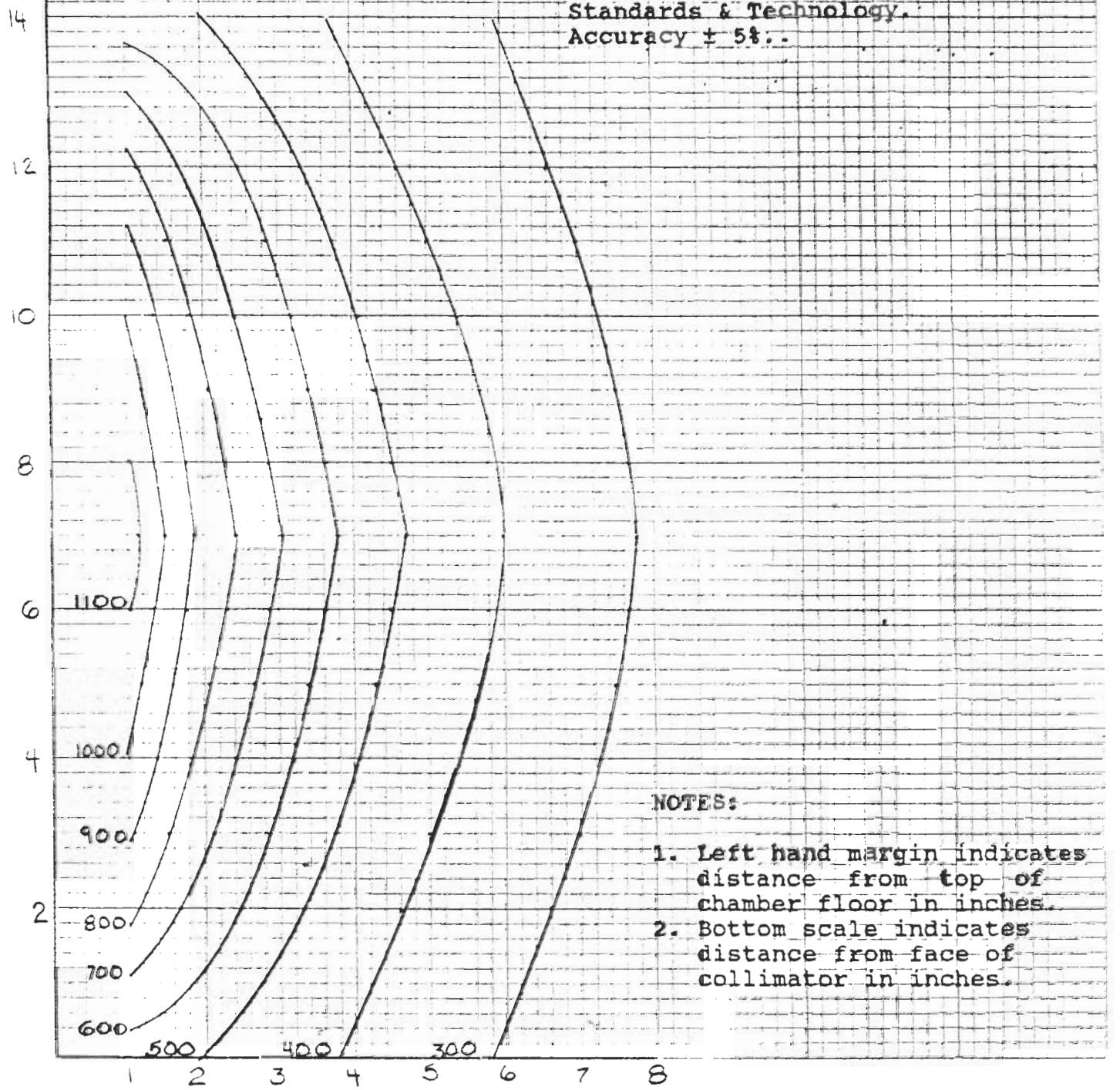
Date: February 28, 1990

Model 335 Collimator in position
All readings are in R/min.
1.0 cm opening.

Scatter Radiation: At 1" outside of beam ≤ 1.0% of direct reading.

Scale = Half

NOTE: All calibration directly traceable to National Institute of Standards & Technology.
Accuracy ± 5%.



NOTES:

1. Left hand margin indicates distance from top of chamber floor in inches.
2. Bottom scale indicates distance from face of collimator in inches.

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Mark I Model 68A, S.N. 1005
11,250 Ci ^{137}Cs

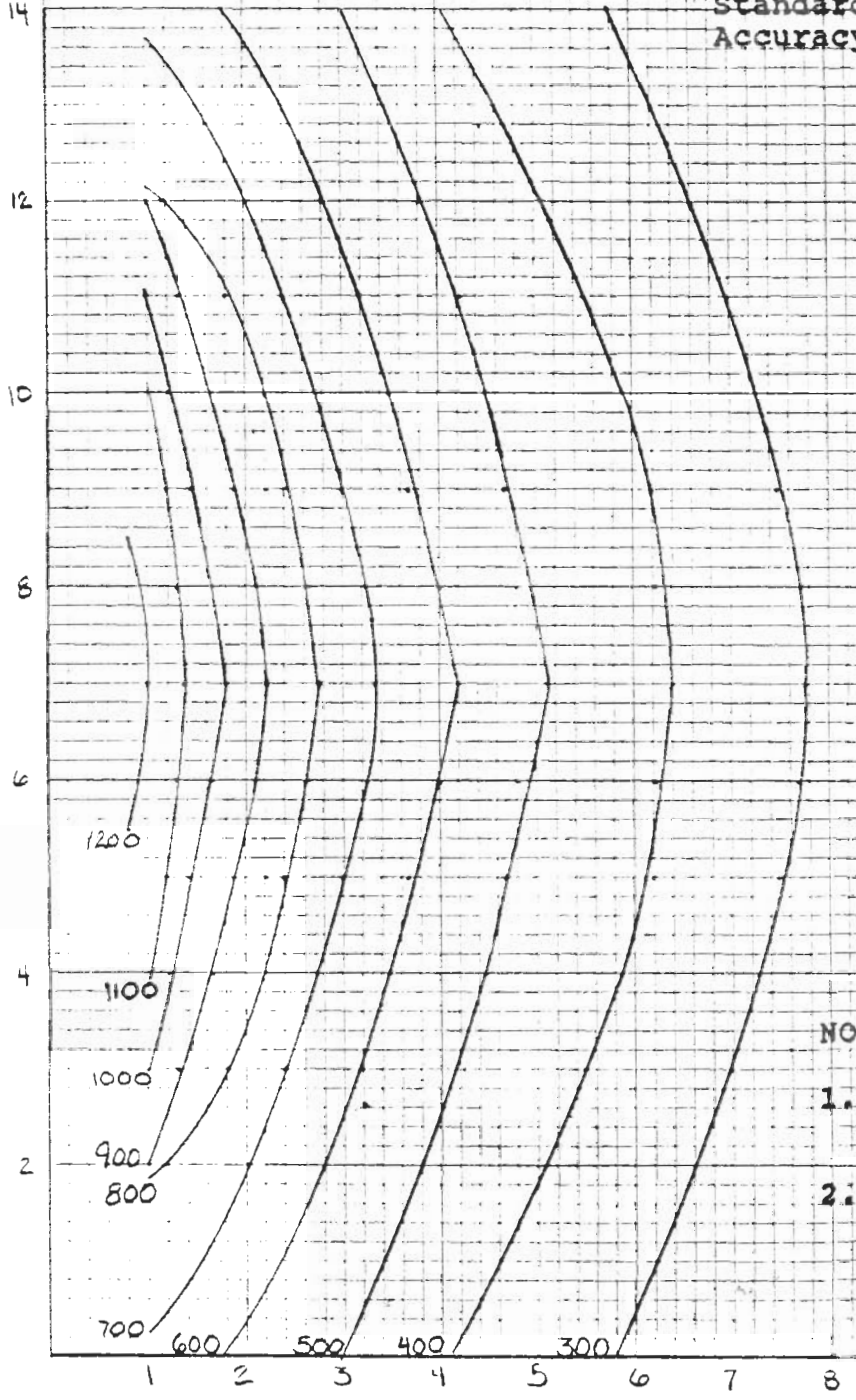
Date: February 28, 1990

Model 335 Collimator in position
All readings are in R/min.
1.7 cm opening.

Scatter Radiation: At 1" outside of beam ≤ 1.0% of direct reading.

Scale = Half

NOTE: All calibration directly traceable to National Imstitute of Standards & Technology.
Accuracy ± 5%.



NOTES:

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2. Bottom scale indicates distance from face of collimator in inches.

Mark I Model 68A, S.N. 1005
11,250 Ci ^{137}Cs

Date: February 28, 1990

Model 335 Collimator in position
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1.0 cm opening.

Scatter Radiation: At 1" outside of beam ≤ 1.0% of direct reading.

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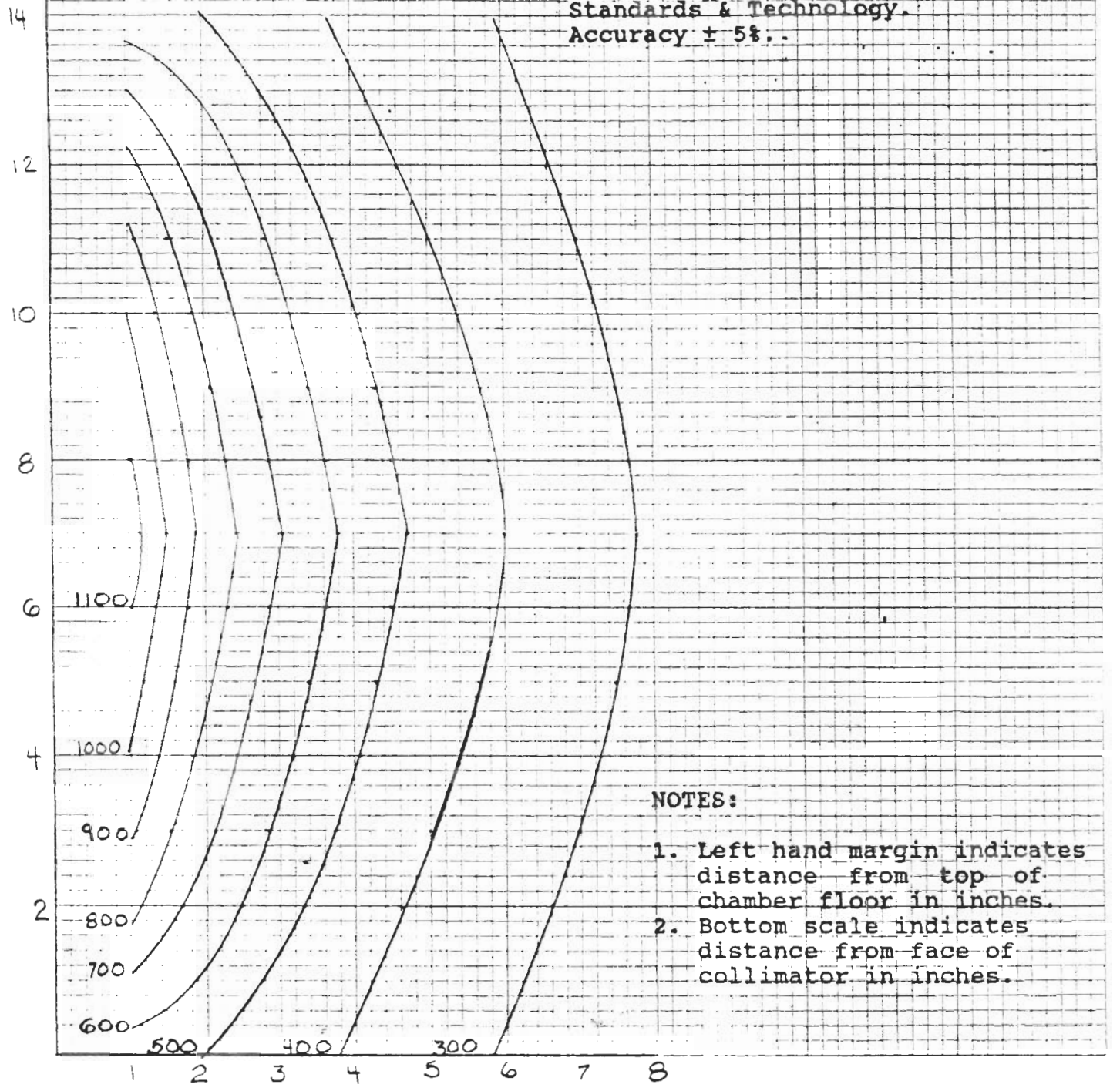

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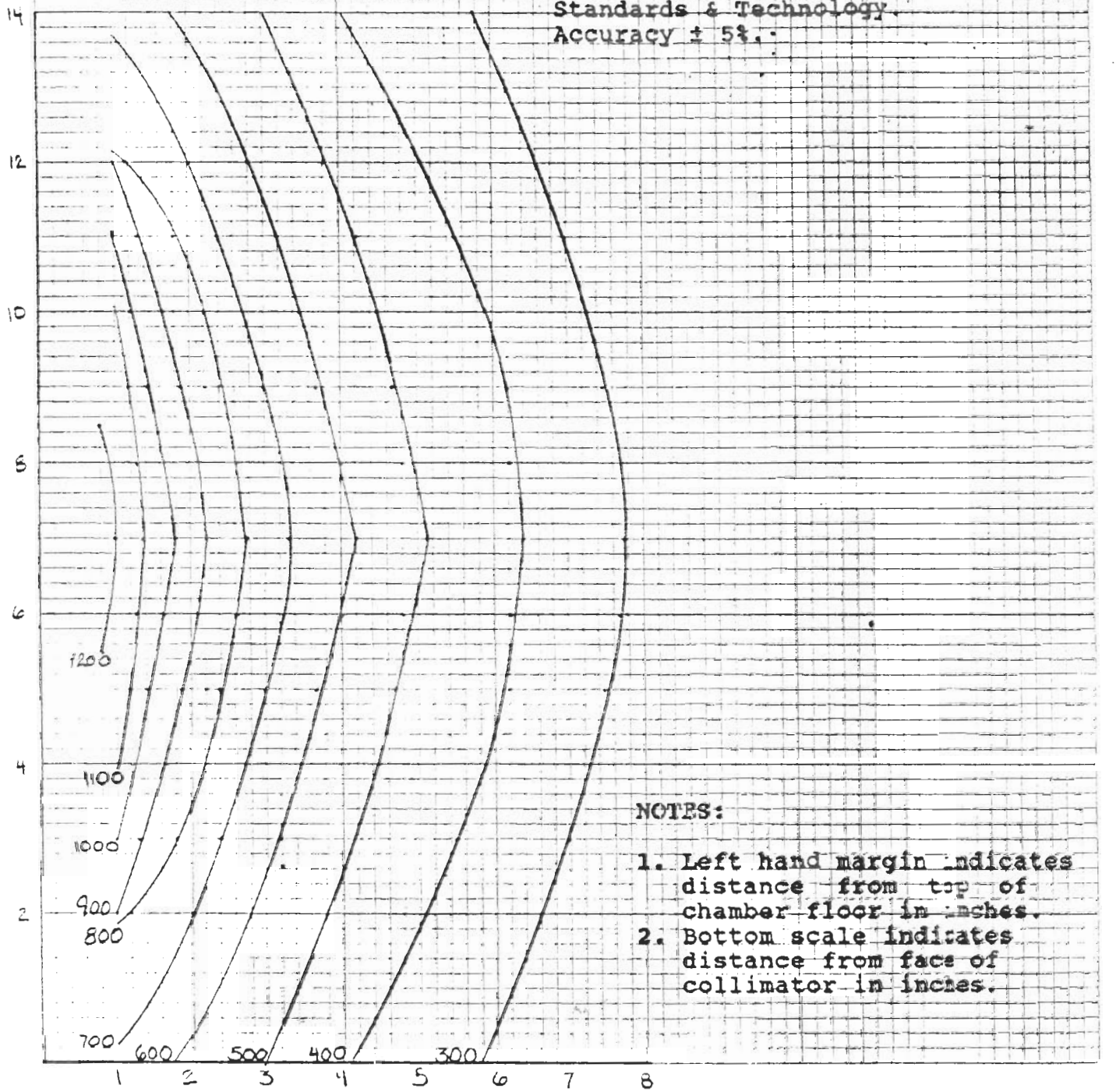

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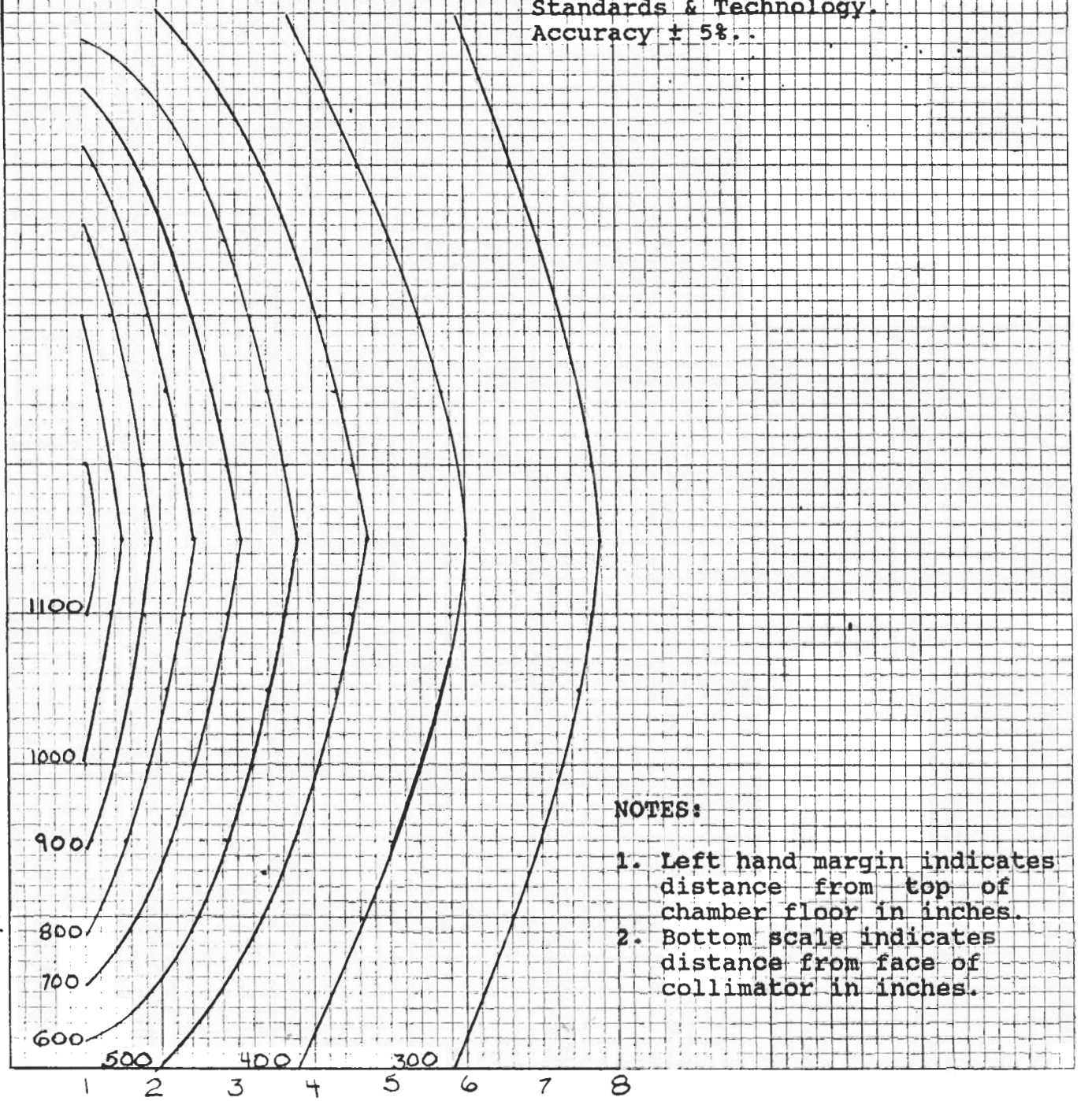
NOTE: All calibration directly traceable to National Institute of Standards & Technology.
Accuracy ± 5%.



NOTES:

1. Left hand margin indicates distance from top of chamber floor in inches.
2. Bottom scale indicates distance from face of collimator in inches.